Global Mangrove Species Distribution and Its Correlation with Population Density and Ecoregions

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Abstract

Mangrove ecosystems hold a crucial role in the biodiversity and ecological processes of coastal areas worldwide. The comprehension of mangrove species' distribution patterns and their association with population density and ecoregions is fundamental for the implementation of efficient conservation and management approaches. Utilizing Geographic Information System (GIS) tools, this research scrutinizes the global distribution of mangrove species and explores their correlation with population density and ecoregions. Information regarding mangrove species distribution, population density, and ecoregional boundaries is gathered from diverse origins and subjected to analysis through GIS spatial analysis methodologies. The outcomes disclose spatial variances in mangrove species richness among different ecoregions, with certain regions displaying no documented occurrences of mangrove species. The graduated classification of mangrove species distribution serves to clarify distribution patterns, whereas frequency counts and summary statistics offer insights into the dataset's central tendency and variability. These discoveries contribute to a more profound comprehension of the elements influencing mangrove species distribution and guide effective conservation and management strategies.

Keywords: Mangrove species, Population density, Ecoregions, GIS analysis, Spatial distribution, Conservation, Biodiversity, Coastal ecosystems, Environmental factors, and Global distribution.

1 Introduction

Mangrove ecosystems rank among the most diverse and productive coastal habitats, delivering vital ecological services and maintaining various species across the globe. An essential aspect for the development of efficient conservation and management approaches is the comprehension of the distribution patterns of mangrove species and the influencing factors on their spatial organization. Through the utilization of Geographic Information System (GIS) tools, this research delves into the worldwide distribution of mangrove species and investigates their relationship with population density and ecoregions. The primary objective is to shed light on the intricate interplay between human activities, environmental determinants, and the biodiversity of mangroves (Huxham et al., 2017, Feller et al., 2010, Romañach et al., 2018; Sarker et al., 2016).

2 Literature Review

Past research has illuminated the critical role of mangrove ecosystems in preserving coastal biodiversity and facilitating a variety of ecological processes. Work from (, Alongi,2008) and (Ellison and colleagues 2019) have highlighted mangroves' contribution to offering habitats for a wide range of species, safeguarding shorelines against erosion, and capturing carbon. Additionally, extensive research has delved into the aspects that shape the distribution and variety of mangroves. The health and integrity of mangrove ecosystems appear to be significantly influenced by the density of nearby human populations. In areas along the coast with high population densities, mangrove areas frequently face human-induced threats like city expansion, contamination, and the destruction of natural habitats (, Islam et al., 2014, Duke, 2017, 2011; Richards & Friess, 2016). Such activities lead to the fragmentation of mangrove areas, a decrease in the diversity of species, and pose risks to the existence of species relying on mangroves for survival (Friess and others, 2016). Ecoregions, characterized by distinct environmental conditions and biotic communities, also play a crucial role in shaping mangrove species distribution. Studies by (Fois et al.,2018; Gilani et al., 2020Chowdhury et al., 2016) have demonstrated the influence of factors such as climate, hydrology, and substrate type on mangrove community composition and structure. Understanding the variation in mangrove species richness across different ecoregions is essential for prioritizing conservation efforts and identifying areas of high biodiversity significance.

3. Methodology

The methodology utilized in this study entails employing Geographic Information System (GIS) tools to scrutinize the global dissemination of mangrove species concerning population density and ecoregions. The subsequent steps delineate the strategy: Data Collection: Acquisition of mangrove species distribution data will be executed from credible sources such as the Global Mangrove Watch database (Islam et al., 2016, Giri et al., 2011) and local studies recording mangrove existence. Population density data will be procured from demographic databases like the World Pop project (Tatem et al., 2017, Biswas et al., 2018), while ecoregional boundaries will be ascertained from recognized classifications such as the World Wildlife The mangrove species distribution data, population density data, and ecoregional boundaries will be imported into GIS software for spatial scrutiny. Layers will be superimposed to investigate the spatial correlation between mangrove existence, population density, and ecoregions. The utilization of GIS tools is intended to carry out spatial analysis, which encompasses hotspot analysis, spatial autocorrelation, and interpolation techniques. The outcomes of these analyses are anticipated to facilitate the identification of regions characterized by high mangrove species richness, areas exhibiting high population density, and ecoregions harboring distinctive mangrove communities. By applying GIS methodologies, the primary objective of this research is to offer valuable insights into the factors influencing the global distribution of mangrove species and their relationship with population density and ecoregions. The comprehension of these associations holds significance in guiding conservation initiatives and advocating for the sustainable governance of mangrove ecosystems on a global scale.

4 Results

4.1 Ecoregions by Number of Mangrove Species

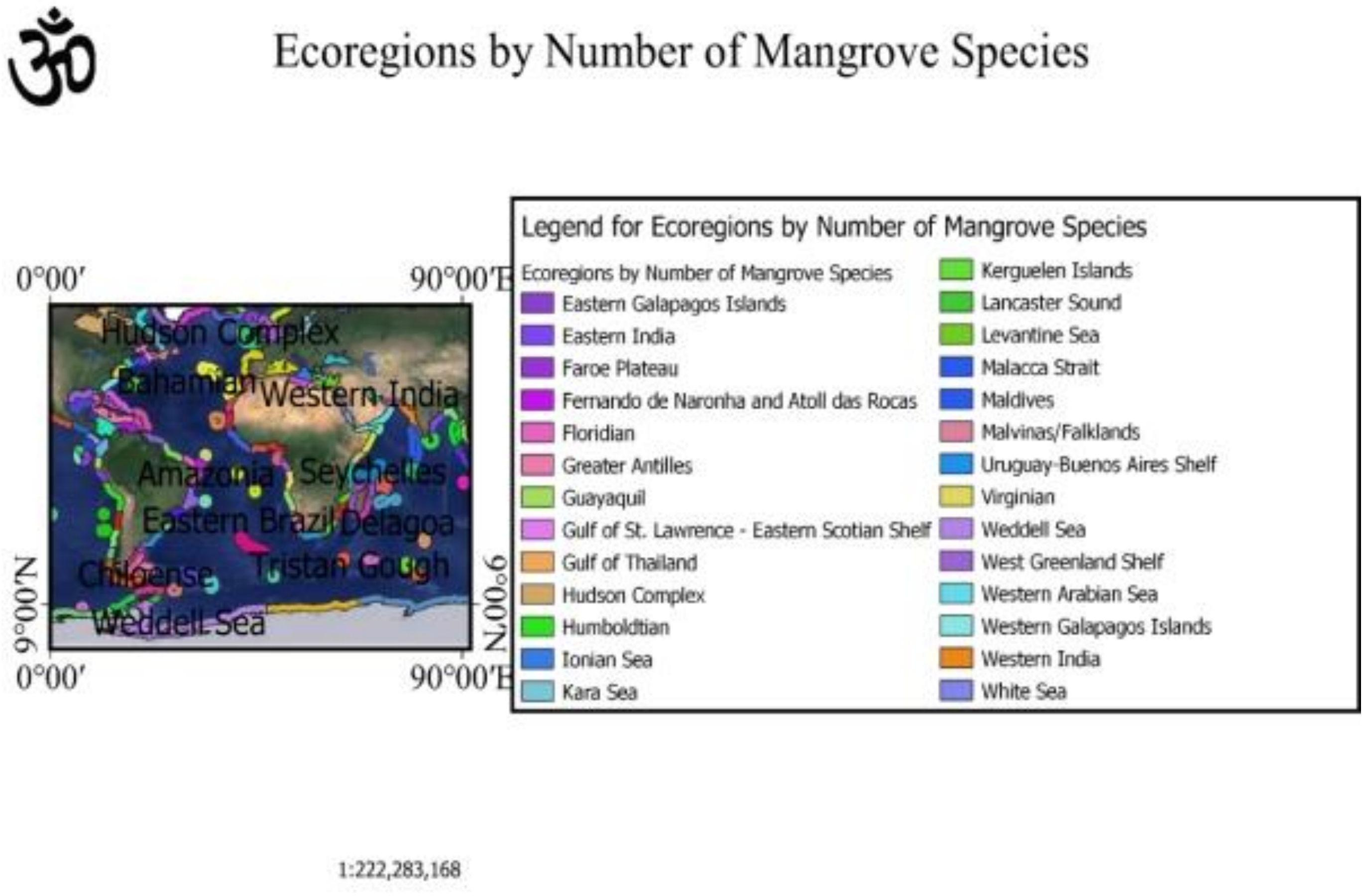


Figure 1. Ecoregions of global Mangrove species.

4.2 Graduated Mangrove Species Distribution Across Different Ecoregions

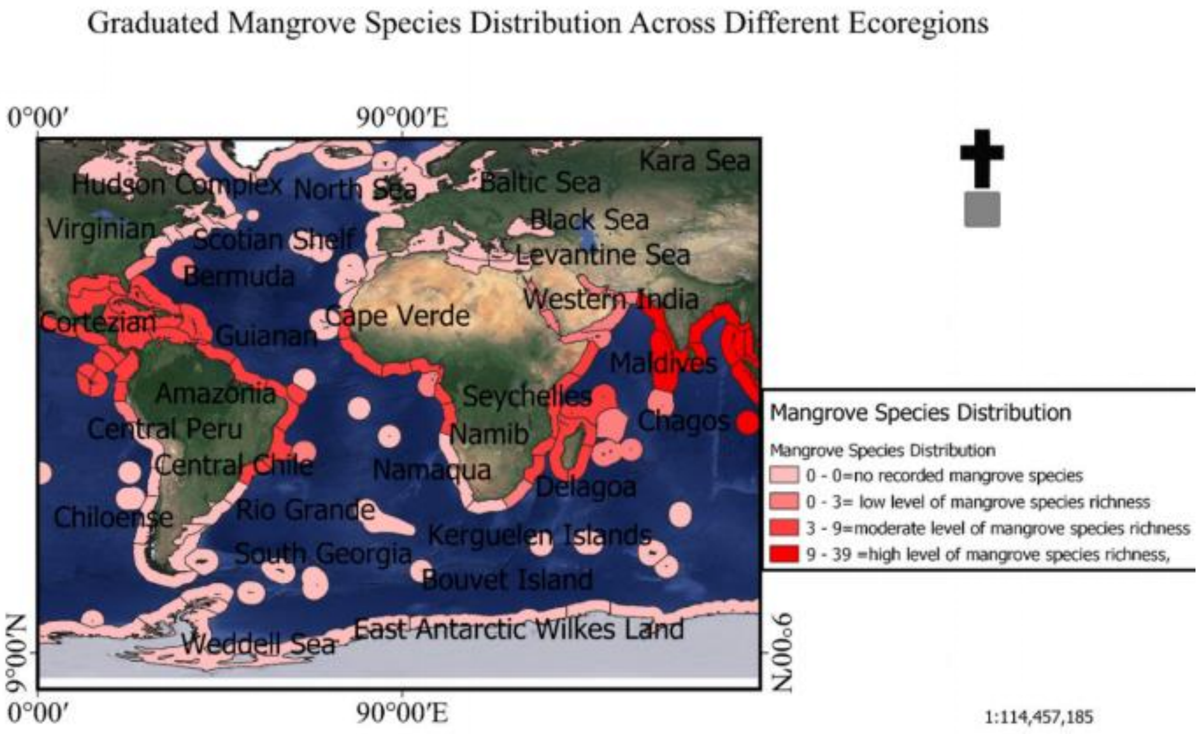
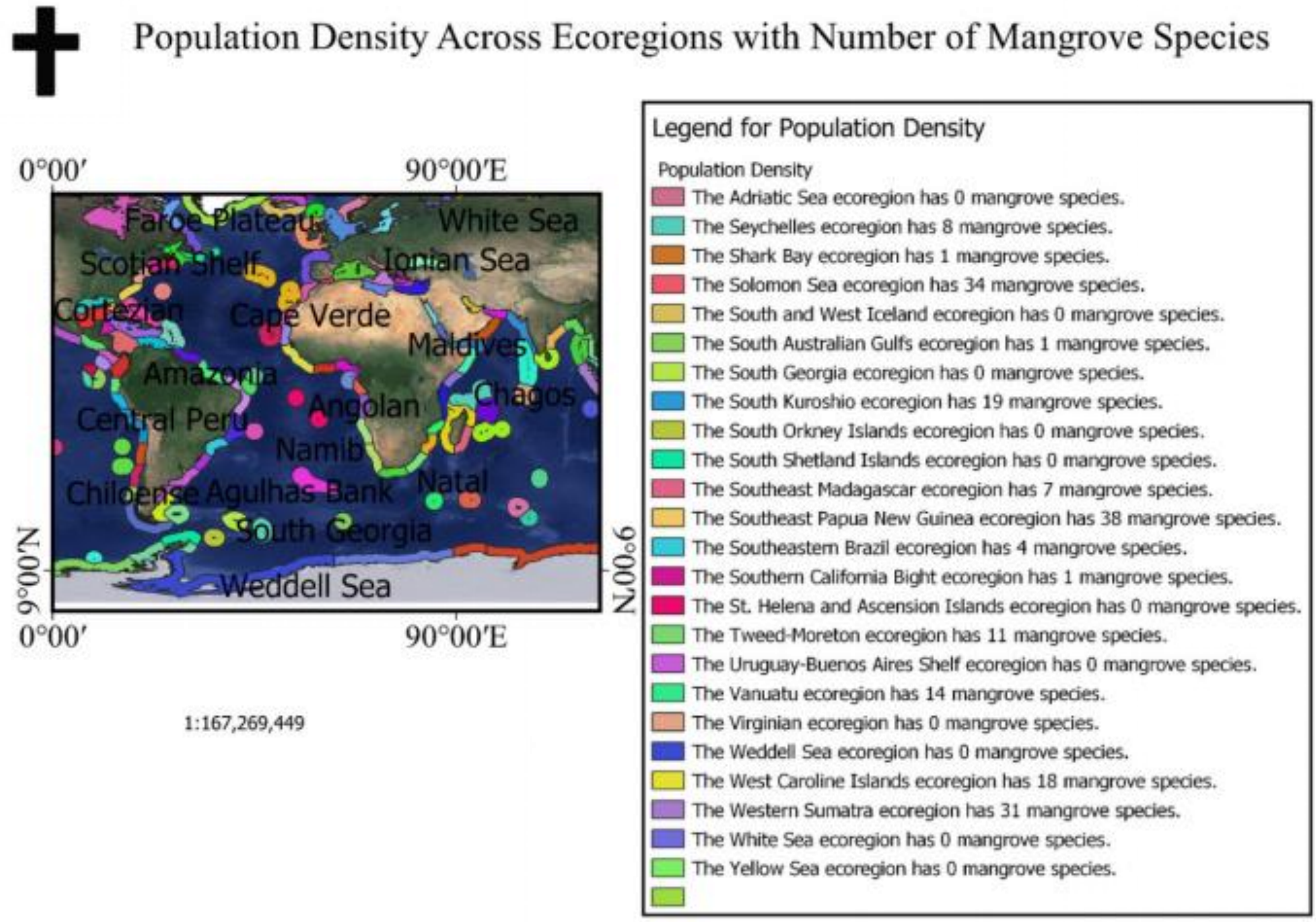

Graduated Mangrove Species Distribution Across Different Ecoregions
0°00′
90°00′E
9°00′N
Hudson Complex
North Sea
Baltic Sea
Kara Sea
Virginian
Scotian Shelf
Black Sea
Levantine Sea
Bermuda
Western India
Cortezian
Guianan
Cape Verde
Maldives
Amazonia
Seychelles
Central Peru
Namib
Chagos
Central Chile
Namaqua
Delagoa
Chiloense
Rio Grande
Kerguelen Islands
South Georgia
Bouvet Island
Weddell Sea
East Antarctic Wilkes Land
Mangrove Species Distribution
Mangrove Species Distribution
0 - 0=no recorded mangrove species
0 - 3= low level of mangrove species richness
3 - 9=moderate level of mangrove species richness
9 - 39 =high level of mangrove species richness,
1:114,457,185

Figure 2. Mangrove species distribution across different ecoregions.

4.3 Population Density Across Ecoregions with Number of Mangrove Species



■ The Adriatic Sea ecoregion has 0 mangrove species.
■ The Seychelles ecoregion has 8 mangrove species.
■ The Shark Bay ecoregion has 1 mangrove species.
■ The Solomon Sea ecoregion has 34 mangrove species.
■ The South and West Iceland ecoregion has 0 mangrove species.
■ The South Australian Gulfs ecoregion has 1 mangrove species.
■ The South Georgia ecoregion has 0 mangrove species.
■ The South Kuroshio ecoregion has 19 mangrove species.
■ The South Orkney Islands ecoregion has 0 mangrove species.
■ The South Shetland Islands ecoregion has 0 mangrove species.
■ The Southeast Madagascar ecoregion has 7 mangrove species.
■ The Southeast Papua New Guinea ecoregion has 38 mangrove species.
■ The Southeastern Brazil ecoregion has 4 mangrove species.
■ The Southern California Bight ecoregion has 1 mangrove species.
■ The St. Helena and Ascension Islands ecoregion has 0 mangrove species.
■ The Tweed-Moreton ecoregion has 11 mangrove species.
■ The Uruguay-Buenos Aires Shelf ecoregion has 0 mangrove species.
■ The Vanuatu ecoregion has 14 mangrove species.
■ The Virginian ecoregion has 0 mangrove species.
■ The Weddell Sea ecoregion has 0 mangrove species.
■ The West Caroline Islands ecoregion has 18 mangrove species.
■ The Western Sumatra ecoregion has 31 mangrove species.
■ The White Sea ecoregion has 0 mangrove species.
■ The Yellow Sea ecoregion has 0 mangrove species.
■

Figure 3. Population density of the number of Mangrove species across Ecoregions.

4.4 Frequency Counts of Population Groups

Statistic	Value
Count	232
Count (distinct)	232
Count (missing)	0
Minimum	The Adriatic Sea ecoregion has 0 mangrove species.
Maximum	The Yellow Sea ecoregion has 0 mangrove species.
Minority	The Adriatic Sea ecoregion has 0 mangrove species.
Majority	The Adriatic Sea ecoregion has 0 mangrove species.
Minimum length	43
Maximum length	84
Mean length	56.2801724137931

Table 1. Frequency Counts of Population Groups

4.5 Summary Statistics of Mangrove Species Distribution

Statistic	Value
Count	232
Sum	1541
Mean	6.64224
Median	1
St dev (pop)	11.2118
St dev (sample)	11.236
Minimum	0
Maximum	39
Range	39
Minority	17
Majority	0
Variety	29
Q1	0
Q3	6
IQR	6
Missing (null) values	0

Table 2. Summary Statistics of Mangrove Species Distribution

4.6 Ecoregional Distribution of Mangrove Species

Statistic	Value
Count	232
Count (distinct)	232
Count (missing)	0
Minimum	Adriatic Sea
Maximum	Yellow Sea
Minority	Adriatic Sea
Majority	Adriatic Sea
Minimum length	5
Maximum length	46
Mean length	18.09051724137931

Table 3. Ecoregional Distribution of Mangrove Species

5 Discussion

Figure 1 depicts the spatial distribution of ecoregions according to the number of mangrove species, highlighting the heterogeneity in mangrove species richness across different biological zones globally (Sarker et al. 2016, Game and Grantham, 2008, Ardron et al., 2010). The presence of mangrove species varies significantly between ecoregions, including the Eastern Galapagos Islands, White Sea, Levantine Sea, and Malacca Strait. Several ecoregions, including the Weddell Sea, Virginian, Helena and Ascension Islands, and the Yellow Sea, have no reported cases of mangrove species, indicating prospective places for future investigation or conservation efforts (Liu et al., 2005,2011). In Figure 2, the graduated classification of mangrove species distribution serves to further clarify the distribution patterns by categorizing ecoregions based on the degree of mangrove species richness (Li et al., 2002). Regions devoid of documented mangrove species, such as the Adriatic Sea, are juxtaposed with those displaying moderate to high levels of species richness, like Western Sumatra, Caroline Islands, and Vanuatu. This classification offers valuable insights into the spatial variability of mangrove ecosystems and emphasizes regions of ecological importance. Supplementing the spatial distribution analysis, Table 1 illustrates frequency counts of mangrove species on a global scale (Au Li et al.,2006; Xu et al., 2005). The data exhibit disparities in the presence of mangrove species, with a large portion of ecoregions reporting no occurrences of mangroves. Particularly, the Adriatic Sea ecoregion emerges as the most prominent with no documented instances of mangrove species, highlighting potential conservation issues or ecological factors that influence species distribution. Table 2 presents a comprehensive analysis of the distribution of mangrove species, providing valuable insights into the central tendency and variability present in the dataset (Jongman & Pungetti,2004). The dataset showcases a mean species count of 6.64, a standard deviation of 11.2, and an interquartile range of 6, highlighting a significant level of variability. The wide range of 39 species indicates the extensive species richness observed on a global scale, while the median value of 1 demonstrates the skewed distribution towards a lower number of recorded species in numerous ecoregions. Table 3 delves deeper into the distribution of mangrove species across different ecoregions, outlining the maximum and minimum species counts within each region (Williams et al. 2004). The variation in species counts among ecoregions, exemplified by the Adriatic Sea being both the most and least abundant, underscores the intricate complexity of mangrove ecosystems and the crucial role of local environmental factors in shaping species distributions.

6 Conclusion

The examination of distribution patterns of mangrove species and variations in ecoregions offers valuable insights into the spatial arrangements and ecological importance of mangrove ecosystems worldwide (Bai et al., 2021, Cabeza et al. 2004). Despite significant disparities in species diversity among ecoregions, certain regions emerge as potential conservation priorities due to the presence or scarcity of mangrove species. Continued monitoring and evaluation of mangrove ecosystems are essential for a more profound comprehension of the factors influencing species distribution and for guiding targeted conservation initiatives (Ellis and Ramankutty, 2008, Williams et al. 2004). Through the integration of spatial analysis methodologies with extensive datasets, scholars can further clarify the intricate relationships between environmental factors and mangrove biodiversity, thus contributing to the sustainable preservation and management of these crucial coastal environments.

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